UNIVERSITI TEKNOLOGI MARA

THE IMPLEMENTATION OF THREE-TERM CONJUGATE GRADIENT METHOD IN INTENSITY-MODULATED RADIATION THERAPY

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ABSTRACT

Optimization involves finding the optimal solution of an objective function. The Conjugate Gradient (CG) method is one of the most widely used methods for solving unconstrained optimization problems. It has been applied in various fields such as robotic motion, image restoration, and regression analysis. The CG method can be classified into several categories, including scaled, three-term, and hybrid CG methods. However, the performance of CG methods depends on the choice of the CG coefficient, and studies on the comparison of Three-Term Conjugate Gradient (TTCG) coefficients for large-scale inverse planning problems are still limited. This research studies the performance of TTCG methods under exact line search and their use in Intensity-Modulated Radiation Therapy (IMRT) fluence map optimization. Five TTCG methods, namely TTRMIL, TTLAMR, TTKMAR, TTSMAR, and TTSFA, are tested on 15 standard test functions with different initial points and variables from 2 to 10,000 variables. The performance is measured by the number of iterations (NOI) and central processing unit (CPU) time. The results are presented using performance profiles, where efficiency is measured by lesser NOI and CPU time, while robustness is measured by the ability to solve all test problems successfully. The TTLAMR coefficient achieves a 100% success rate and requires fewer iterations and lesser CPU time compared to most of the other TTCG methods. All five coefficients are then applied to a clinical prostate IMRT fluence map optimization problem. On this application, TTKMAR converges in the fewest iterations, while TTLAMR attains the lowest final objective value, and the leading coefficients all produce clinically acceptable treatment plans. This shows that the best coefficient on the standard test functions is not necessarily the best in the clinical application.